Review of Aberdein/Read: The Philosophy of Alternative Logics

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Aberdein, Andrew and Read, Stephen
The Philosophy of Alternative Logics. *The Development of Formal Logic,* 613–723, Oxford University Press, New York, 2009

This survey article consist of two parts followed by a conclusive summary and a brief section with bibliographic hints for "Further Reading". The first part (pp. 613–640) is devoted to a consideration of the question "What Are Alternative Logics?" whereas the second part with the title "What Alternative Logics Are There?" (pp. 641–695) provides four case studies of alternative logics, namely intuititionistic logic, quantum logic, relevance logic, and paraconsistent logic.

The dynamics of theories and the relationships between competing theories are standard issues in the philosophy of science. However, most of the discussions of these topics deal with theories from the empirical sciences. The first part of Aberdein's and Read's article therefore is devoted to the development of a suitable framework for the discussion of these problems with respect to logical theories. In this endeavour the authors are very much inspired by the work of Imre Lakatos (cf. MR0560905 and MR0479916). A logical theory is conceived of as a tool for the formal analysis of natural language argumentation just as theories from empirical disciplines like physics and chemistry are tools for the analysis of natural phenomena. A logical theory comprises four components (1) a formal system together with (2) a formal semantics and a corresponding metatheory, (3) a scheme for the regimentation and translation of natural language sentences and for the conversion of natural language arguments into deductions of the formal system, and (4) a "goal". This goal specifies the essential property which—according to the theory at issue—differentiates valid arguments from invalid ones. Thus, for instance, preservation of truth (from arguments to conclusion) is the goal of classical logic (**K**) whereas "intuitionist logic is motivated by the preservation of warrant" (p. 617) and paraconsistent logic "is concerned to avoid triviality rather than falsehood" (*ibid.*). The formal system of a logical theory is viewed as the codification of the theory's notion of logical consequence rather than as a means for the enumeration of recognized logical truth or as a definition of the proper notion of proof (p. 614). The just listed four components of a logical theory make up its "foreground". Usually, a logical theory is supplemented by one or more "background theories" providing its philosophical motiviations (p. 618). — An alternative logic is a proposal for the revision of classical logic in response to a philosophical or scientific problem. In the history of logic alternative logics often developed by successive critical assessments of different traits of classical logic. This means that revisionary programs typically develop stepwise in time. Hence it is necessary to introduce into the philosophy of science of logical theory a number of concepts—such as "revolution", "research program", "hard core" (of a theory), "heuristic" (of a research program), *etc.*—which have been found useful in the discussion of the dynamics of empirical theories. The first part of the article thus ends up with an elobarate classificatory hierarchy of revisionary approaches to classical logic.

The first concrete alternative logic discussed in the article's second part is intuitionistic logic **J** (p. 641–656). The historical origin of intuitionistic logic is briefly described and the Brouwer-Heyting-Kolmogorov interpretation of the intuitionistic connectives is provided. Mathematical constructivism and semantic

antirealism (as argued for by, for instance, Prawitz and Dummett) are discussed as philosophical background theories motivating **J**. The relationship between **J** and **K** is treated both from a formal and philosophical perspective. The question whether **J** is preferable to **K** because its (natural deduction) formalizations exhibits some distinguished features (such as invertability of deduction rules and normalizability of proofs) is discussed and answered negatively. The critical issue in the debate between intuitionistic and classical logic does not reduce to the question whether formalizations of **J** have some distinguished properties lacked by formalizations of **K** but rather concerns the philosophical background question of inferential goal (preservation of warrant *vs.* preservation of truth *simpliciter*). The authors argue that the importance of this question also sets intuitionist logic apart from other revisions of classical logic. Wheras other alternative logic theories attempt to retain the inferential goal of classical logic and instead aim at a more transparent translation component, the two philosophical background theories for **J** which have been treated in the article (mathematical constructivism and semantic antirealism) aim at a substantial revision of principles valid within the classical account.

The second alternative logic considered in the article is quantum logic (p. 656–668). The system **QL** of quantum logic deriving from the work of von Neumann and Birkhoff (cf. MR1435976, MR1503312) is briefly described together with what might be called its "Hilbert space semantics". What renders quantum logic attractive as an alternative to **K** is its claim that its adoption does not commit one to "the counterintuitive metaphysical consequences" normally associated with quantum mechanics (p. 656). The discussion of **QL** following the presentation of that system does not, however, attempt to decide on the justification of that claim but rather considers the conceptual viability of the revisionary project of quantum logic. Three mutually related issues are discussed: (1) the compatibility of quantum logic with realism (p. 658–661), (2) the adequacy of Dummett's analysis of logical revisionism as leading up either to cases of mutual unintelligibility or mere relabeling (p. 661–664), (3) the relationship between the meanings of the logical connectives of **K** and of **QL** (p. 664–668).

Intuitionistic logic and quantum logic have in common that they differ from classical logic in their being based upon assumptions and doctrines completely alien to the classical attitude: for example, the thesis of the inadmissability of non-constructive reasoning in the case of intuitionistic logic and the view that logical principle are revisable in view of empirical facts in the case of quantum logic. The next two logics considered in the article, namely relevance logic and paraconsistent logic, are rather amendments than alternatives to classical logic. — As regards relevance logic (p. 668–682), the paradoxes of material and strict implication, the critical logical principles used in their deduction (such as the disjunctive syllogism, monotonicity, the deduction theorem, *etc.*), and the innovations of relevant logics (such as the fusion connective and intensional disjunction) are discussed. Anderson and Belnap's formal systems **R** and **E** (cp. MR0406756 and MR1223997) deriving from the works of Ackermann, Moh, and Church (cf. MR0080607 and MR0040236) and their status as substructural logics are explained. The model theory of relevant logic is sketched both in the style of the Meyer-Routley semantics (with its ternary accessibility relation) and the relational-operational semantics of Kit Fine. In the discussion of the "relevantist background philosophy" different forms of adherence to the

"relevantist program" (soft, hard, and true relevantism) are distinguished with regard to their attitude toward the disjunctive syllogism. The question whether the formal semantics of relevance logic have intuitive foundations strong enough to qualify relevance logic as a plausible reform program is extensively discussed.

Paraconsistent logics (p. 682–695) admit for inconsistent theories containing propositions together with their negations. In the framework of classical logics with its principle *ex contradictione quodlibet* (ECQ) ($A, \neg A \models B$) such inconsistent theories all coincide with the entire set of all propositions (of the underlying formal language). Paraconsistent logics allow for "paraconsistent theories" containing non-trivial inconsistencies which do not "detonate" in the way just described. Two kinds of motivation are distinguished for the admittance of paraconsistent theories: (1) *Weakly* paraconsistent research programs in logic agree with the background philosophy of classical logic on the assumption that reality is free of contradictions. Contradictions arise only within collections of propositions accepted by some (human and/or artificial) reasoners due to some kind of error committed by them. Thus, for example, a database may have been updated at different times by data contradicting each other. In such cases, one would nevertheless often not like to give up the entire theory (database) in spite of its known inconsistency. Rather one would try to restrict in some way the devastating effects of the contradiction caused by ECQ to delimited and isolated portions of the entire theory. (2) *Dialetheism* (cf. MR1014684) holds that paraconsistent theories may be accurate theories of reality. Thus, according to this attitude, contradictions are due to reality itself rather than to logical errors of reasoners. — On the technical level, two strategies for the formal development of a paraconsistent logic are discussed: (1) that of da Costa's and Newton's use of a series $\mathbf{C}_n$ ($0 \leq n \leq \omega$) of successive logical systems (cf. MR0354361) and (2) the use of a logic which roughly conforms to the relevantist program by modifying the conditional connective. It is argued that the first strategy leads up to serious problems with negation and with the conditional connective. The relationship between paraconsistent logics and classical logic is investigated, and in this a special focus is given to the consideration of those two connectives.

Reviewed by Klaus Robering